CUMING

TECHNICAL NOTE 600-1

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THERMAL INSULATING PROPERTIES OF SYNTACTIC FOAM

INTRODUCTION

As offshore production of oil and gas has moved into deeper water, the importance of keeping the pipeline contents warm and flowing has increased. Syntactic foam, with its great strength, light weight, and high thermal efficiency, is the ideal subsea insulation material. The following is a general overview of the subject. For more detailed product information, see the 600-Series of ***C-THERM*** technical bulletins, listed on page 2.

SYNTACTIC FOAM

Syntactic foam is an advanced composite material of glass or ceramic microspheres cast into a binder matrix of rigid, semi-rigid, or elastomeric plastic resin. Sometimes larger fiberglass macrospheres or other fillers are also used. The chemical and mechanical properties of these versatile materials are adaptable to almost any operating condition.

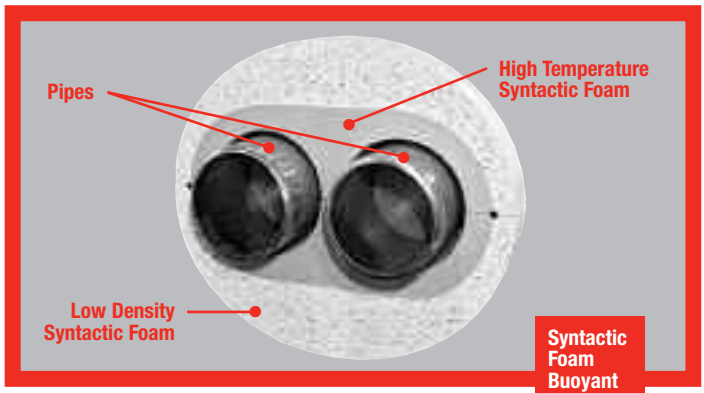
MATERIALS SYSTEMS

The efficiency of syntactic foam depends on reinforcement of the spherical fillers by the surrounding matrix. Because all plastics lose some of their strength at elevated temperature, syntactic insulation materials must be designed with the effects of heat in mind. If flexibility is desired, this, too, will have the effect of reducing strength and requiring more density for a given depth rating, as shown in Chart 1 below.

CHART 1

Syntactic Foam Insulation Materials Systems

Type of Spherical Filler	Properties with Rigid Binder	Properties with Flexible Binder
Solid Syntactic Glass Microspheres Only	Rigid, strongest, Medium density, Greatest depth	Most flexible, Highest density, Medium depth
Composite Glass Micros and Fiberglass Macrospheres	Rigid and strong Lowest density Medium depth	Limited flexibility Medium density Least depth

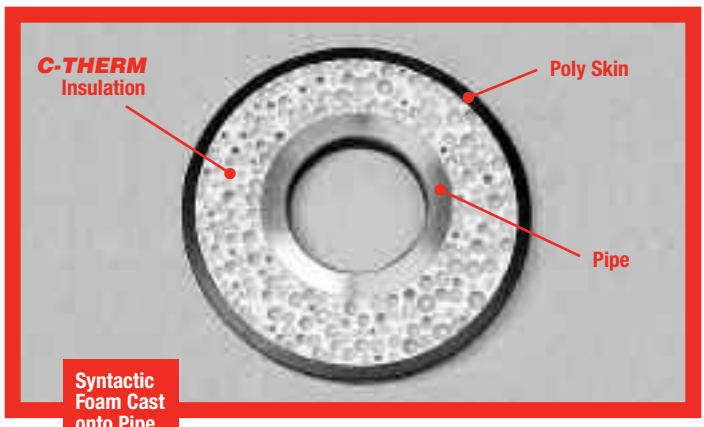


FORMS AVAILABLE

Syntactic foam insulation is available in a wide range of forms to suit the application:

PRE-CAST SLEEVES AND SHAPES: Half-shells or custom shapes of syntactic foam can be bolted or strapped onto pipe, as shown above.

CAST-ON-PIPE: Patented techniques can be used to cast the syntactic foam directly onto the pipe, as illustrated in the photo below.



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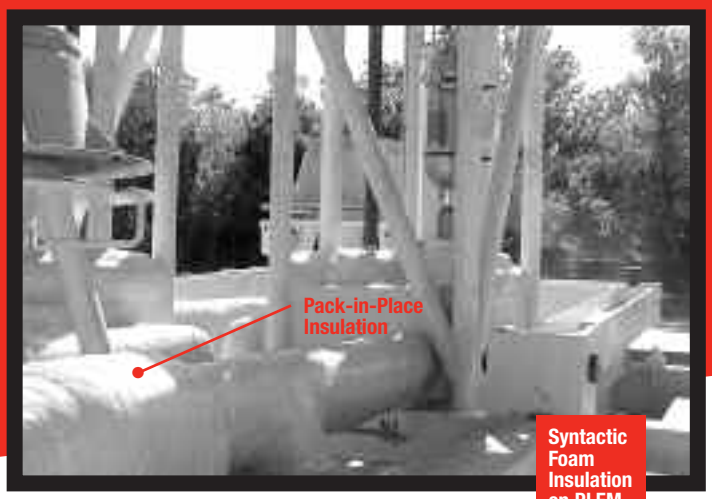
FIELD-APPLIED KITS: Syntactic foam kits and tapes can be packed in place, poured into place, or wrapped around pipes and subsea equipment, as shown below.



BUOYANT INSULATION

Most syntactic materials weigh much less than sea water, and thus contribute buoyancy to the equipment being insulated. In some cases this is a good thing, allowing buoyancy and insulating functions to be integrated. In other cases, it may be undesirable and must be accounted for in the design of the system. ***C-THERM*** materials can be engineered to meet almost any requirement.

A unique feature of syntactic foam is that buoyant insulation can be formed from single castings, greatly simplifying assembly and deployment, and reducing total system cost. The top photo on page one illustrates hybrid buoyant insulation made by combining an inner layer of high temperature resistant solid syntactic with an outer layer of low density composite foam.

Chart 2 summarizes the properties of typical syntactic foam subsea insulation systems. For more specific information on the ***C-THERM*** line of products, consult the following Technical Bulletins:

- TB 601 Overview of the ***C-THERM*** product line
- TB 610 Cast-on Pipe syntactic foam insulation
- TB 615 Buoyant syntactic foam insulation
- TB 625-1 Pre-cast insulation blocks and shapes
- TB 625-2 Pour-in-place syntactic foam insulation
- TB 625-3 Pack-in-place syntactic foam insulation

TB 650 Syntactic insulation field joint systems

- TB 660 Insulating tapes and wrapping systems
- Also see product-specific Data Sheets in each category.

Testing methods commonly used for qualifying subsea insulation materials include the following:

- Density ASTM D 792
- Thermal Conductivity ASTM C 518
- Specific Heat ASTM C 351
- Compressive Strength ASTM D 695
- Tensile Strength ASTM D 1623
- Hydrostatic Strength ASTM D 2736

CHART 2

Typical Properties of Syntactic Foam Subsea Insulation Materials

Max Operating Temperature, C (F)	Max Service Depth, m (ft)	Rigid			Semi-Rigid			Flexible		
		Nominal Density, kg/m3 (lbs/ft3)	Thermal Conductivity, W/m-K (Btu/hr-ft-F)	Specific Heat, J/g-C (Btu/lb-F)	Nominal Density, kg/m3 (lbs/ft3)	Thermal Conductivity, W/m-K (Btu/hr-ft-F)	Specific Heat, J/g-C (Btu/lb-F)	Nominal Density, kg/m3 (lbs/ft3)	Thermal Conductivity, W/m-K (Btu/hr-ft-F)	Specific Heat, J/g-C (Btu/lb-F)
<60 (<140)	—	Note: Use conventional syntactic foam buoyancy materials for temperatures below 60 C (140 F).								
80 (176)	2300 (7500)	600 (38.0)	0.14 (0.080)	1.34 (0.32)	673 (42.0)	0.15 (0.085)	1.36 (0.33)	770 (48.0)	0.16 (0.090)	1.60 (0.38)
100 (212)	2300 (7500)	660 (41.0)	0.15 (0.085)	1.36 (0.33)	721 (45.0)	0.16 (0.090)	1.38 (0.34)	817 (51.0)	0.17 (0.095)	1.65 (0.40)
120 (248)	2300 (7500)	720 (45.0)	0.16 (0.090)	1.38 (0.34)	769 (48.0)	0.17 (0.095)	1.40 (0.35)	880 (55.0)	0.18 (0.100)	1.70 (0.41)
>120 (>248)	—	Note: Request information on new "HTHP" materials for service above 120 C (248 F) or for greater depth.								

Important Note: This is not a controlled document. All values are approximate, and subject to change without notice. Consult the appropriate Technical Bulletins and current product-specific Data Sheets for the most accurate and timely information.

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